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Author(s): Davydov, Jerry Sergei

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Nuclear Forensics National Frameworks

Briefing to Nuclear Smuggling Detection and Deterrence Regulatory Documents & Procedures Team Meeting

7-9 December 2021

Jerry Davydov
Nuclear and Radiochemistry (C-NR)

07 December 2021

What is Nuclear Forensics?

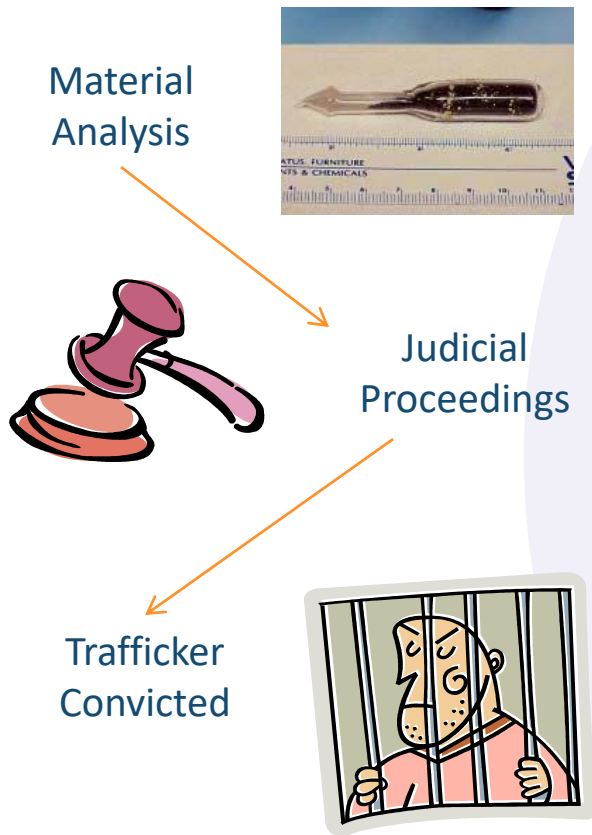
- Nuclear forensics is the examination of nuclear or other radioactive material, or of evidence contaminated with radionuclides, in the context of legal proceedings under international or national law related to nuclear security
- The goal of forensic science is to discover **linkages among people, places, materials, and events**
- Nuclear forensics is an essential component of national response plans to events involving nuclear or other radioactive materials out of regulatory control and **informs prevention, detection, and response**



Nuclear Forensics Part 1: Evidence

Part 1: Supporting Prosecutions

Link individuals to criminal activity



Support to law enforcement and prosecutorial bodies

- Technical evidence for judicial proceedings
- Requires high-quality, legally defensible analyses
 - What is it?
 - How much is there?
 - Was a law violated?
- Does not generally require a detailed analysis of all material attributes

Most countries have the technology, equipment and expertise for these analyses

Nuclear Forensics Part 2: Nuclear Security Architecture

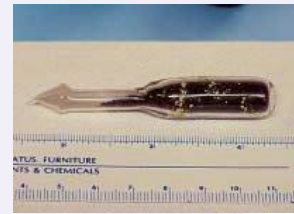
Support to law enforcement and regulatory investigators

- Detailed analysis of material attributes
- Expert evaluation and comparative analysis
- Assessment of material origin
- To address questions of prevention, detection, and response to nuclear security events
 - Weaknesses in physical protection and control
 - Vulnerabilities at borders and other nodal points
 - Insider involvement

Requires advanced capabilities, e.g. laboratory analysis, data interpretation, national nuclear forensics library

Part 2: Supporting Determinations of Nuclear Security Efficacy

History and provenance of nuclear material

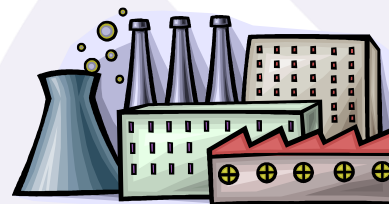
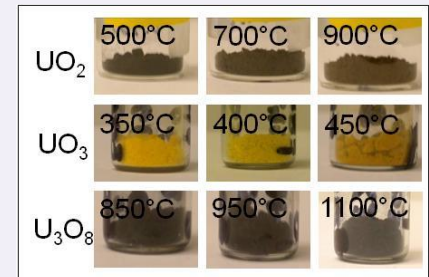


Full Characterization

- Precision isotopics
- Chemical composition
- Age dating
- Morphology

Comparative Analysis

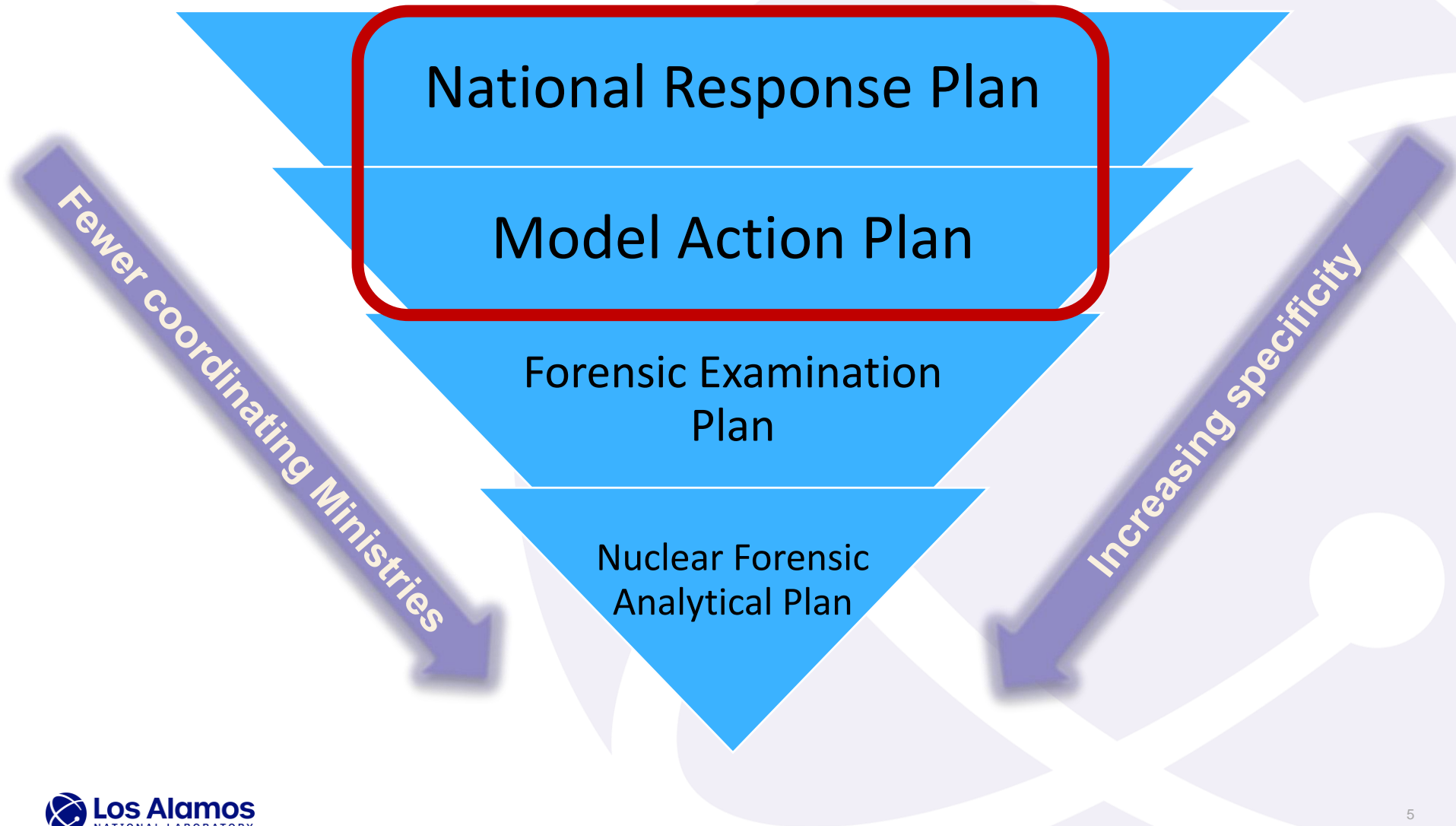
- Intended use
- Process history
- Fuel cycle information



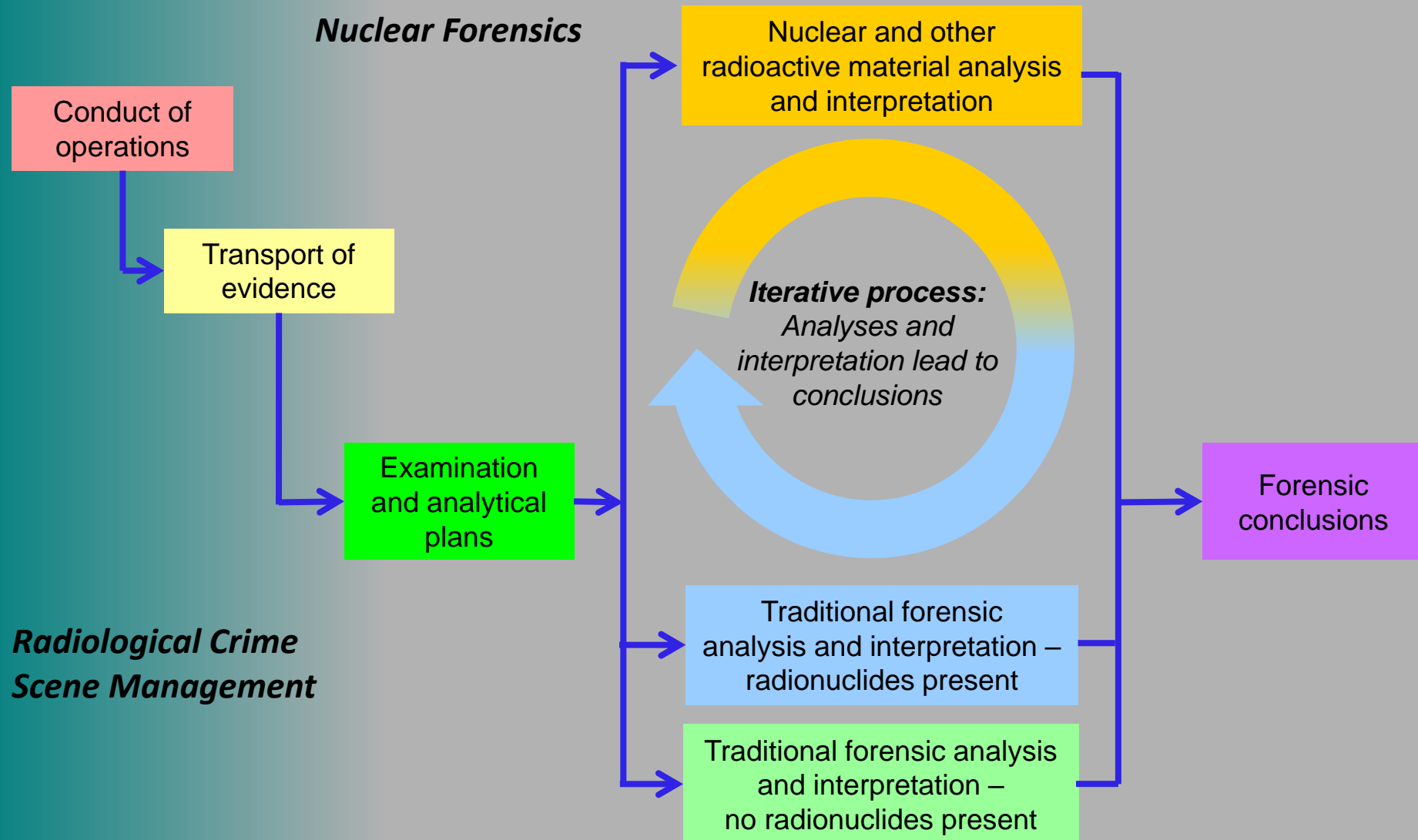
Outcome

- Possible origins
- Connections between cases
- Enhanced security

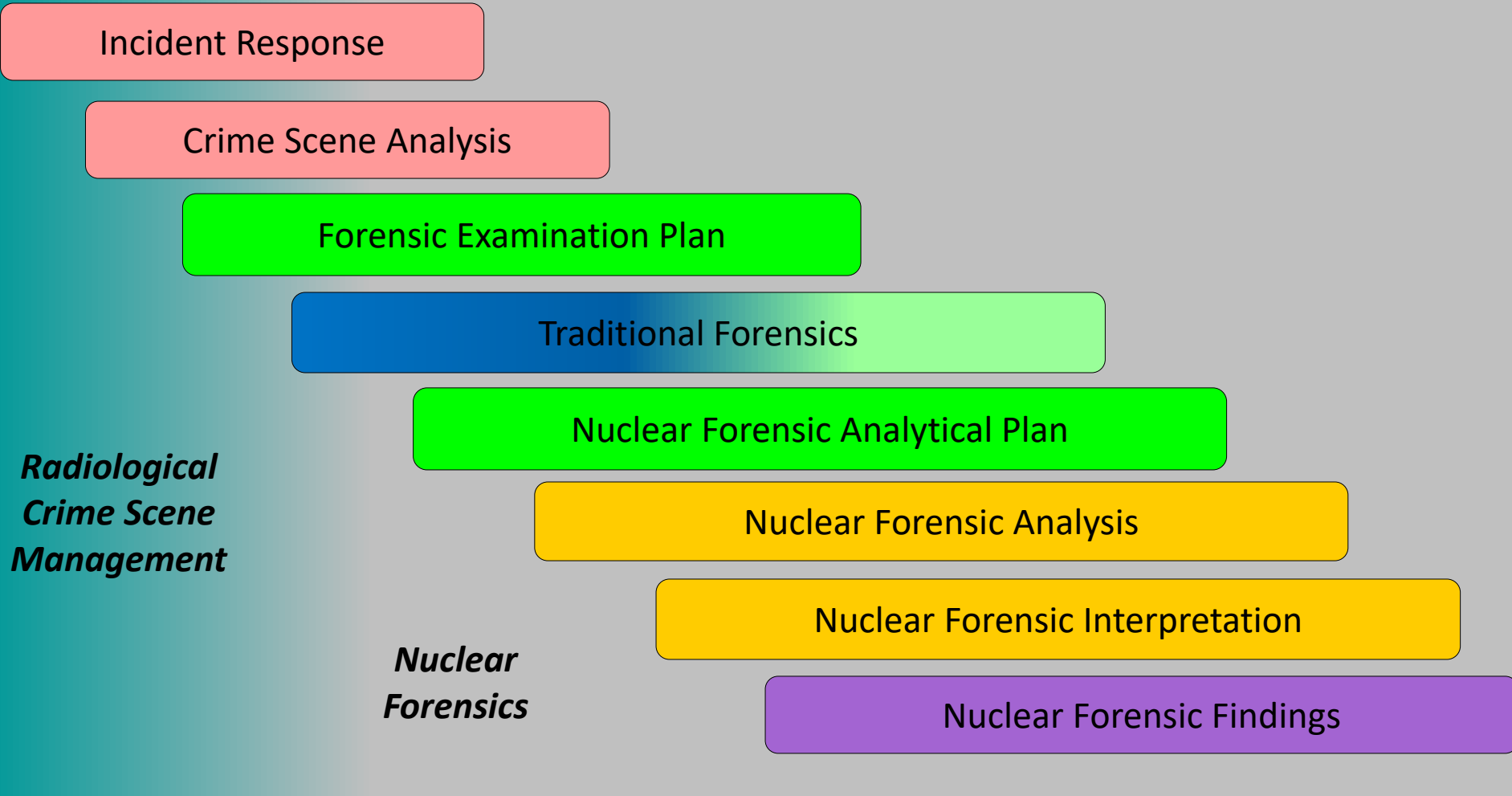
Hierarchy of Plans



Model Action Plan



Course and Conduct of a Nuclear Forensic Examination in Support of an Investigation



Incident Response

Radiological Crime Scene Management

- Securing the site:
Law enforcement secures the site of the nuclear security event
- Hazards assessment:
Experts identify the material and the potential radiation or nuclear hazard



Crime Scene Analysis

On-scene Analysis: Categorization

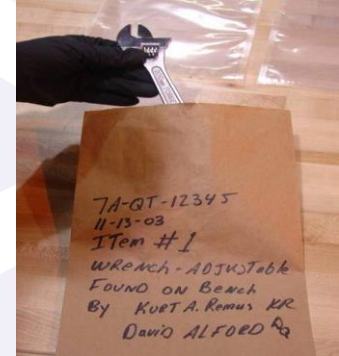
- Identify nuclear security implications and the risk of the seized material to the first responders, law enforcement personnel, and the public.
- Hand-held radioisotope identification devices (RIDs) allow identification of the radionuclide
- Allows appropriate response and follow-on actions



Crime Scene Analysis

Evidence Collection: Radioactive and traditional

- Preservation of evidence
- Collection of traditional forensic evidence and evidence contaminated with radionuclides should be performed in a manner consistent with radiation safety practices



Chain of custody

- Procedures and documents that account for the integrity of physical evidence by tracking its handling and storage from the point of collection to its final disposition.
- It details who's had it and that no “deleterious” change has occurred

SEALED EVIDENCE	
DATE _____	INITIALS _____
SEALED EVIDENCE	

EVIDENCE	
Submitting Agency _____	
Date Collected _____	Time _____
Item # _____	Case # _____
Collected By _____	
Description of Evidence _____	
Location Where Collected _____	
Type of Offense _____	
CHAIN OF CUSTODY	
Rec. From _____	By _____
Date _____	Time _____
Rec. From _____	By _____
Date _____	Time _____
Rec. From _____	By _____
Date _____	Time _____

Evidence Holding and Transport

Evidence Holding Site

- May require an interim location to store material
- Need to ensure that safety and security measures are in place to prevent evidence tampering
- Need appropriate permits to handle and transport radiation and chemical hazards

Evidence Transport

- Packaging and transportation of evidence needs to satisfy the legal, safety and security requirements of the State (or States) in which the shipment is occurring



Forensic Examination Plan

- The **proper sequencing** of both traditional and nuclear forensic examination of exhibits is required, to ensure that:
 - ✓ Essential information is obtained expediently
 - ✓ As much data as possible can be derived from a finite sample (non-destructive techniques first)
- Specify whether evidence contaminated with radionuclides will be analysed as is or will require **decontamination** prior to examination
- Material **sampling and distribution**
 - ✓ Cannot assume that material is homogeneous
 - ✓ Special attention and planning are needed when only a small amount of sample is available
 - ✓ Special precautions should be taken to avoid the destruction of forensic traces



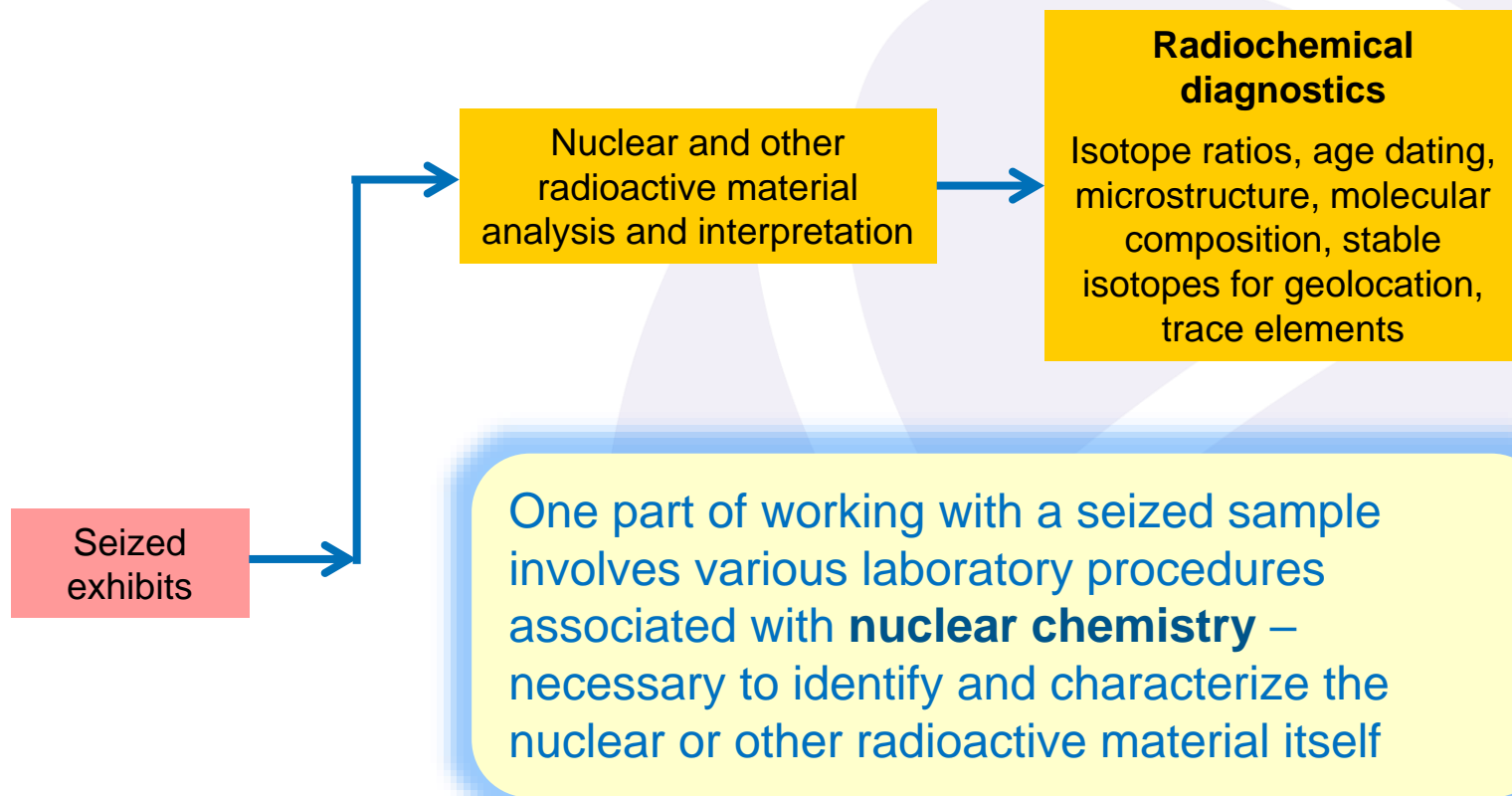
The plan can, and should, be modified as necessary, based on results and information to date

Nuclear Forensic Analytical Plan

- Describes the types of analyses to meet the requirements of the investigation and the sequencing of analyses
- Laboratory considerations:
 - ✓ Identify **procedures** that will be followed
 - ✓ Determine the **quantity** of material needed for each analysis
 - ✓ Consider any **foreseen deviations** from documented procedures
- Address any required interface with traditional forensic analyses

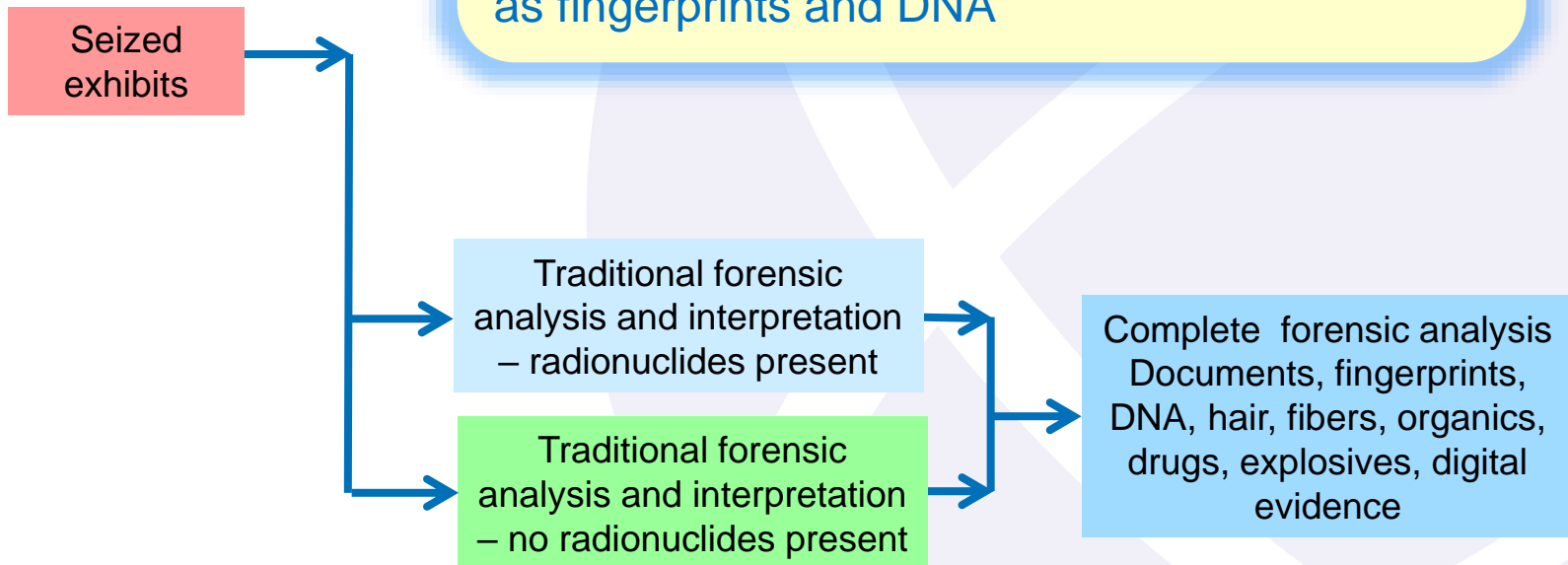
The Nuclear Forensic Analytical Plan can be modified as necessary based on results and information to date

Nuclear Forensic Analysis



Traditional Forensics

A second, equally important, part of working with a seized sample involves various laboratory procedures associated with **forensic sciences** – e.g. traditional examinations such as fingerprints and DNA



Nuclear Forensic Interpretation

- **Nuclear forensic interpretation:**
 - ✓ Is the process of comparing and associating sample characteristics with existing information
 - ✓ Provides the context, explanations for the analytical results, and the basis of the nuclear forensic findings
 - ✓ Typically requires subject matter experts, for example, from across the fuel cycle, radiochemistry and environmental science
- **Nuclear forensic signatures** may be compared with reference signatures for processes and facilities throughout the nuclear fuel cycle
- A **national nuclear forensics library** is one of the tools that can be used for nuclear forensic interpretation

The ability to **compare signatures** with existing knowledge and data is central to nuclear forensic interpretation

Nuclear Forensic Findings

- **Nuclear forensics findings** are the product of nuclear forensic analysis and interpretation
- In general, **confidence in findings** depends on three factors: validated methods, certified reference materials and demonstrated competencies
- **Communication** of findings:
 - ✓ All nuclear forensic findings should be communicated in a written report in a timely manner
 - ✓ The forensic examination plan should outline the specific form and timeframes in which findings should be communicated
 - ✓ Reports may be issued periodically
 - ✓ Final report after the examination has been concluded



Summary of Plans

Name of Plan	Objective	Who is Involved
National Response Plan	National level document identifying roles and responsibilities of all relevant competent authorities in a nuclear security event	Ministerial level officials tasked with interagency coordination
Model Action Plan	Guidance for the process of nuclear forensic support to an investigation	Law enforcement, transportation, technical reach back/expert support, and judicial personnel involved in the incident
Forensic Examination Plan	Addresses the needs of the investigation, sequencing of analyses, the expected timeframes for both nuclear material and traditional forensic evidence examinations	Law enforcement, traditional forensic experts and other technical experts
Nuclear Forensic Analytical Plan	Describes the specific analyses which will be performed in the laboratory	Technical experts



Investigation Support Capacity-Building Toolbox

The four pillars of NSDD Investigation Support

